CLAIMS

What is claimed is:

1. A method, a sensor array that employs a parameter to induce a time-varying phase angle φ on an optical signal that comprises a phase generated carrier with a demodulation phase offset β, the method comprising the steps of:

filtering an output signal from the sensor array to create a filtered signal; and

calculating the phase angle φ independently of the demodulation phase offset β through employment of the filtered signal.

2. The method of claim 1, further comprising the step of:

sampling an output signal from the sensor array to obtain a plurality of samples S_n, wherein $n = 0$ to x;

wherein the step of calculating the phase angle φ independently of the demodulation phase offset β through employment of the filtered signal comprises the step of:

calculating the phase angle φ independently of the demodulation phase offset β through employment of one or more of the plurality of samples S_n.

3. The method of claim 1, wherein the step of calculating the phase angle φ independently of the demodulation phase offset β through employment of the one or more of the plurality of samples S_n comprises the steps of:

calculating one or more quadrature terms and one or more in-phase terms through employment of one or more of the plurality of samples S_n, wherein one or more of the one or more quadrature terms and one or more of the one or more in-phase terms are substantially independent from the demodulation phase offset β; and

calculating the phase angle φ through employment of the one or more quadrature terms and the one or more in-phase terms.

4. The method of claim 2, wherein the output signal comprises a period T_{pulse}, wherein the step of sampling the output signal from the sensor array to obtain the plurality of samples S_n, wherein $n = 0$ to x comprises the step of:

sampling the output signal from the sensor array to obtain a plurality of samples S_n within a period T_s, wherein $n = 0$ to x, wherein T_s is less than or equal to T_{pulse}.

5. The method of claim 4, wherein the step of calculating the phase angle φ independently of the demodulation phase offset β through employment of the one or more of the plurality of samples S_n comprises the steps of:

calculating one or more quadrature terms and one or more in-phase terms through employment of one or more of the plurality of samples S_n, wherein one or more of the one or more quadrature terms and one or more of the one or more in-phase terms are substantially independent from the demodulation phase offset β;

calculating the phase angle φ through employment of the one or more quadrature terms and the one or more in-phase terms.

6. The method of claim 5, wherein the step of calculating the one or more quadrature terms and the one or more in-phase terms through employment of the one or more of the plurality of samples S_n, wherein the one or more of the one or more quadrature terms and the one or more of the one or more in-phase terms are substantially independent of the demodulation phase offset β comprises the steps of:

calculating a set of quadrature terms Q_j and a set of in-phase terms I_k through employment of one or more of the plurality of samples S_n, wherein $j = 0$ to y, wherein $k = 0$ to z;

calculating a quadrature term $Q_s = \sqrt{\sum_{j=0}^{j=y} Q_j^2}$, wherein Q_s is substantially independent of the demodulation phase offset β;

calculating an in-phase term $I_s = C_1 \times \sqrt{\sum_{k=0}^{k=z} I_k^2}$, wherein I_s is substantially independent of the demodulation phase offset β; and

calculating the constant C_1 such that a maximum magnitude of the quadrature term Q_s and a maximum magnitude of the in-phase term I_s comprise a substantially same magnitude for a modulation depth M of an operating range for the phase generated carrier.

7. The method of claim 6, wherein $x = 7$, $y = 3$, $z = 1$, wherein the step of calculating the set of quadrature terms Q_j and the set of in-phase terms I_k through employment of the one or more of the plurality of samples S_n, wherein $j = 0$ to y, wherein $k = 0$ to z comprises the steps of:

calculating $Q_0 = S_0 - S_4$;

calculating $Q_1 = S_1 - S_5$;

calculating $Q_2 = S_2 - S_6$;

calculating $Q_3 = S_3 - S_7$;

calculating $I_0 = (S_0 + S_4) - (S_2 + S_6)$; and

calculating $I_1 = (S_1 + S_5) - (S_3 + S_7)$.

8. The method of claim 6, wherein $x = 15$, $y = 7$, $z = 3$, wherein the step of calculating the set of quadrature terms Q_j and the set of in-phase terms I_k through employment of the one or more of the plurality of samples S_n, wherein $j = 0$ to y, wherein $k = 0$ to z comprises the steps of:

calculating $Q_0 = S_0 - S_8$;

calculating $Q_1 = S_1 - S_9$;

calculating $Q_2 = S_2 - S_{10}$;

calculating $Q_3 = S_3 - S_{11}$;

calculating $Q_4 = S_4 - S_{12}$;

calculating $Q_5 = S_5 - S_{13}$;

calculating $Q_6 = S_6 - S_{14}$;

calculating $Q_7 = S_7 - S_{15}$;

calculating $I_0 = (S_0 + S_8) - (S_4 + S_{12})$;

calculating $I_1 = (S_1 + S_9) - (S_5 + S_{13})$;

calculating $I_0 = (S_2 + S_{10}) - (S_6 + S_{14})$; and

calculating $I_1 = (S_3 + S_{11}) - (S_7 + S_{15})$.

9. The method of claim 6, wherein the step of calculating the phase angle φ through employment of the one or more quadrature terms and the one or more in-phase terms comprises the steps of:

calculating a quadrature term Q from a magnitude of the quadrature term Q_s and one or more quadrature terms of the set of quadrature terms Q_j;

calculating an in-phase term I from a magnitude of the in-phase term I_s and one or more in-phase terms of the set of in-phase terms I_k; and

calculating the phase angle φ of the output signal from an arctangent of a quantity Q / I.

10. An apparatus, a sensor array that employs a parameter to induce a time-varying phase angle φ on an optical signal that comprises a phase generated carrier with a demodulation phase offset β, the apparatus comprising:

a filter component that filters an output signal from the sensor array to create a filtered signal; and

a processor component that employs the filtered signal to calculate the phase angle φ independent from the demodulation phase offset β.

11. The apparatus of claim 10, wherein the processor component obtains a plurality of samples S_n of the filtered signal, wherein $n = 0$ to x;

wherein the processor component employs one or more of the plurality of samples S_n to calculate the phase angle φ independent from the demodulation phase offset β.

12. The apparatus of claim 11, wherein the processor component employs one or more of the plurality of samples S_n of the output signal to calculate one or more quadrature terms and one or more in-phase terms, wherein one or more of the one or more quadrature terms and one or more of the one or more in-phase terms are substantially independent from the demodulation phase offset β of the phase generated carrier;

wherein the processor component employs the one or more quadrature terms and the one or more in-phase terms to calculate the phase angle φ.

13. The apparatus of claim 11, wherein the output signal comprises a period T_{pulse}, wherein the processor component obtains the plurality of samples S_n within a period T_s, wherein T_s is less than or equal to T_{pulse}.

14. The apparatus of claim 13, wherein the processor component employs one or more of the plurality of samples S_n of the output signal to calculate one or more quadrature terms and one or more in-phase terms, wherein one or more of the one or more quadrature terms and one or more of the one or more in-phase terms are substantially independent from the demodulation phase offset β of the phase generated carrier;

wherein the processor component employs the one or more quadrature terms and the one or more in-phase terms to calculate the phase angle φ.

15. The apparatus of claim 14, wherein the one or more of the one or more quadrature terms comprise a quadrature term Q_s, wherein the one or more of the one or more in-phase terms comprise an in-phase term I_s;

wherein the processor component employs one or more of the plurality of samples S_n, the quadrature term Q_s, and the in-phase term I_s to calculate the phase angle φ.

16. The apparatus of claim 15, wherein the processor component employs the plurality of samples S_n to calculate a set of quadrature terms Q_j and a set of in-phase terms I_k, wherein $j = 0$ to y, wherein $k = 0$ to z;

wherein the processor component employs the set of quadrature terms Q_j and the set of in-phase terms I_k to calculate the quadrature term Q_s, and the in-phase term I_s.

17. The apparatus of claim 16, wherein the processor component calculates a constant C_1, wherein the processor component calculates:

$$Q_s = \sqrt{\sum_{j=0}^{j=y} Q_j^2} \; ;$$

wherein the processor component calculates:

$$I_s = C_1 \times \sqrt{\sum_{k=0}^{k=z} I_k^2} \; ;$$

wherein the processor component calculates the constant C_1 such that a magnitude of the quadrature term Q_s and a magnitude of the in-phase term I_s comprise a substantially same magnitude at a modulation depth M of an operating range for the phase generated carrier.

18. The apparatus of claim 17, wherein the processor component employs the quadrature term Q_s and the set of quadrature terms Q_j to calculate a quadrature term Q, wherein the processor component employs the in-phase term I_s and the set of in-phase terms I_k to calculate an in-phase term I;

wherein the processor component calculates:

$Q = \pm\, Q_s$;

wherein the processor component calculates:

$I = \pm\, I_s$;

wherein the processor component employs the set of quadrature terms Q_j to determine a sign of Q;

wherein the processor component employs the set of in-phase terms I_k to determine a sign of I;

wherein the processor component calculates:

$\varphi = \text{arctangent}\,(\,Q\,/\,I\,)$.

19. The apparatus of claim 18, wherein $x = 7$, $y = 3$, and $z = 1$;

wherein the processor component calculates:

$Q_0 = S_0 - S_4$, $Q_1 = S_1 - S_5$, $Q_2 = S_2 - S_6$, and $Q_3 = S_3 - S_7$;

wherein the processor component calculates:

$I_0 = (S_0 + S_4) - (S_2 + S_6)$; and

$I_1 = (S_1 + S_5) - (S_3 + S_7)$.

20. The apparatus of claim 18, wherein $x = 15$, $y = 7$, and $z = 3$;

wherein the processor component calculates:

$Q_0 = S_0 - S_8$, $Q_1 = S_1 - S_9$, $Q_2 = S_2 - S_{10}$, $Q_3 = S_3 - S_{11}$,

$Q_4 = S_4 - S_{12}$, $Q_5 = S_5 - S_{13}$, $Q_6 = S_6 - S_{14}$, and $Q_7 = S_7 - S_{15}$;

wherein the processor component calculates:

$I_0 = (S_0 + S_8) - (S_4 + S_{12})$, $I_1 = (S_1 + S_9) - (S_5 + S_{13})$,

$I_2 = (S_2 + S_{10}) - (S_6 + S_{14})$, and $I_3 = (S_3 + S_{11}) - (S_7 + S_{15})$.

21. The apparatus of claim 10, wherein the period T_{pgc} of the phase generated carrier comprises a frequency f_{pgc} equal to $1 / T_{pgc}$, wherein the frequency f_{pgc} is approximately between 2 MHz and 20 MHz, wherein the phase generated carrier comprises a modulation depth M approximately between 1.0 radians and 1.7 radians, wherein the filter component comprises a 3dB roll-off frequency approximately between 10 MHz and 60 MHz.

22. The apparatus of claim 21, wherein the filter component comprises a fourth order Bessel low-pass filter.

23. The apparatus of claim 21, wherein the filter component comprises a fourth order real pole filter.

24. An article, a sensor array that employs a parameter to induce a time-varying phase angle φ on an optical signal that comprises a phase generated carrier with a demodulation phase offset β, the article comprising:

one or more computer-readable signal-bearing media;

means in the one or more media for filtering an output signal from the sensor array to create a filtered signal; and

means in the one or more media for calculating the phase angle φ independently of the demodulation phase offset β through employment of the filtered signal.

25. The article of claim 24, further comprising:

means in the one or more media for sampling the filtered signal to obtain a plurality of samples S_n, wherein $n = 0$ to x;

wherein the means in the one or more media for calculating the phase angle φ independently of the demodulation phase offset β through employment of the filtered signal comprises:

means in the one or more media for calculating the phase angle φ independently of the demodulation phase offset β through employment of one or more of the plurality of samples S_n.

26. The article of claim 25, wherein the means in the one or more media for calculating the phase angle φ independently of the demodulation phase offset β through employment of the one or more of the plurality of samples S_n comprises:

means in the one or more media for calculating one or more quadrature terms and one or more in-phase terms through employment of one or more of the plurality of samples S_n, wherein one or more of the one or more quadrature terms and one or more of the one or more in-phase terms are substantially independent from the demodulation phase offset β; and

means in the one or more media for calculating the phase angle φ through employment of the one or more quadrature terms and the one or more in-phase terms.

27. The article of claim 26, wherein the output signal comprises a period T_{pulse}, wherein the means in the one or more media for sampling the output signal from the sensor array to obtain the plurality of samples S_n, wherein $n = 0$ to x comprises:

means in the one or more media for sampling the output signal from the sensor array to obtain the plurality of samples S_n within a period T_s, wherein $n = 0$ to x , wherein T_s is less than or equal to T_{pulse}.

28. The article of claim 27, wherein the means in the one or more media for calculating the phase angle φ independently of the demodulation phase offset β through employment of the one or more of the plurality of samples S_n comprises:

means in the one or more media for calculating one or more quadrature terms and one or more in-phase terms through employment of one or more of the plurality of samples S_n, wherein one or more of the one or more quadrature terms and one or more of the one or more in-phase terms are substantially independent from the demodulation phase offset β; and

means in the one or more media for calculating the phase angle φ through employment of the one or more quadrature terms and the one or more in-phase terms.

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